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Protected Areas legislation and the conservation of the Colombian Orinoco basin natural ecosystems

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Abstract

Colombia has shown a strong commitment to the achievement of the CBD's biodiversity target, by promoting the conservation of at least 10% of its natural ecosystems. Protected Area categories in Colombia are undergoing a standardization process that should enhance the country's capacity to protect its natural ecosystems. In this study we use a spatial analysis to examine how the legislation and the civil society's initiatives help in the conservation of natural ecosystems in the Colombian Orinoco Basin. We found that differentiation in use restriction legislation limits the conservation potential of some Protected Area categories. The only fully Protected Areas in Colombia are the Natural National Parks System Areas, which protect only 10% of the area of natural ecosystems and less than 50% of the natural ecosystems in the Colombian Orinoco Basin. Indigenous Reserves help significantly in the conservation of the natural ecosystems in the Colombian Orinoco Basin, but are not a Protected Area category, making it difficult for indigenous groups to aid in the accomplishment of conservation goals in Colombia.

A small percentage of ecosystems of the Colombian Orinoco Basin fall outside of any Protected Area or Indigenous Reserve and urgent actions may be needed to protect them. Future similar studies should use current and updated information on Protected Areas and take into account changes in land cover, for a better understanding of the role of different categories of Protected Areas in the achievement of conservation objectives in Colombia.

Keywords

National System of Protected Areas, Orinoco Basin, Ecosystem Coverage, Indigenous Reserves, Private Protected Areas

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Introduction

Colombia has shown a strong commitment to the achievement of the CBD's 2010 biodiversity target. Just recently the Ministry of Environment passed a decree to standardize the Protected Area categories and to organize the National System of Protected Areas (SINAP in Spanish). The SINAP will need guidelines for the management and establishment of Protected Areas in Colombia. Thus, evaluations of the ecosystem coverage and effectiveness of Protected Areas is necessary. Here we present an overview of the Protected Areas management in Colombia and the implications for the conservation of the natural ecosystems in the Colombian Orinoco Basin.

Protected Areas in Colombia

The first Protected Areas in Colombia were established by the 2nd law of 1959 under the category of Forest Reserves, with the purpose of preserving Colombia's water supply and wildlife. But the concept of Protected Area was not clearly defined by Colombian legislation until 1994, when the government ratified the CBD with the law 165 of 1994, using the same wording used by the Convention to give a definition to the concept of a Protected Area: "a geographically defined area, which is designated or regulated and managed to achieve specific conservation objectives" (Ponce de Leon 2005).

Since then, a great number of Protected Areas have been established without specific standards or criteria, mainly due to flaws within the legislation. For example, some areas have been created by institutions authorized to do so but without proper use of the categories recognized by Colombian legislation (Ponce de Leon 2005; Vásquez-V. and Serrano-G. 2009). This situation lead to a great number of Protected Areas to be left out of any protection scheme, as they were not strictly legally established Protected Areas.

In a recent inventory of Protected Areas in Colombia, the National Natural Parks Office reported a total of 419 Protected Areas in Colombia, established under 181 designations of which only 11 were legally supported (Tamayo 2009).

National system of Protected Areas

Aware of the problem identified above, the Ministry of Environment has been working together with all the stakeholders on consolidating and coordinating the National System of Protected Areas (Sistema Nacional de Areas Protegidas – SINAP) which has been defined by the decree 2372 of 2010 as: "the set of protected areas, social and institutional stakeholders and the strategies and management tools that bring them together, contributing as a whole to the fulfillment of the general conservation objec-

tives of the country". This decree classifies and describes the categories of the SINAP, setting a target to redefine all categories and designations used before, so that they fit the legally accepted categories, by July 2011, going from more than 43 to only 8 subcategories and designations. Legally, only three Protected Area management categories will be accepted: areas managed by the national government, areas managed by the regional government and areas managed by private landowners. The national government Protected Areas are administered by the Ministry of Environment, and are divided into three subcategories. The regional government Protected Areas are divided into five subcategories and are administered by the Regional Environmental Agencies (Corporaciones Autonomas Regionales – CARs). In 1993 the law 99 allowed the existence of Protected Areas managed by private landowners, following an initiative of the private landowners themselves, to aid in the *in situ* conservation of biological diversity in Colombia. Most Private Protected Areas in Colombia are grouped into different non-governmental associations that help coordinate conservation actions between landowners.

Protected Areas with full protection

The World Conservation Union (IUCN) defines a Protected Area as: "A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley 2008). Strict compliance to this definition would result in some of the Protected Area categories and subcategories in Colombia not to be considered as Protected Areas. For example, the constitution states that all of Colombia's subsoil is property of the State, under this premise, any land portion that has been proven to contain oil or any other mineral is subject to exploitation by the government or a private organization commissioned by the State, and although a number of laws have been emitted in order to prevent this from happening in Protected Areas, only some categories have been effectively protected.

Regarding oil exploitation, the decree 622 from 1997 prohibits any exploration and extraction inside one of the subcategories of the national government Protected Areas, the National Natural Parks System Areas (NNPSA). Areas that are forbidden for extraction of other minerals are the NNPSA´s and some subcategories within the national and regional governmental Protected Areas. A further examination of the legislation shows that the only PA´s established in perpetuity are the NNPSA´s, as has been determined by the constitution. Unfortunately this is almost impossible to implement for the other Protected Area categories in Colombia. As a result of these gaps in Colombian legislation for Protected Areas, only a very small proportion is truly protected: the 55 NNPSA´s, as the other ca. 400 are not protected from mining, oil exploration and exploitation, and possible disappearance.

Other areas of special interest for biodiversity conservation in Colombia

The constitution allows ethnic groups to own and administer the territories they occupy, in order to protect their cultural heritage and, traditional knowledge and ways of life. A total of 738 ethnic collective territories have been assigned to afro-descendant communities and indigenous groups in Colombia, adding up to 435,000 km^2 (Tamayo 2009). These territories have not been created to achieve conservation objectives and thus are not included in the SINAP. But they pose a great opportunity for biodiversity conservation, as the traditional ways of life of indigenous people are usually sustainable and environmentally friendly.

Colombian Orinoco basin

The Orinoco River flows 2,140 km from the Andes in Colombia to the Atlantic in Venezuela. Its tributary rivers form a basin considered to be the 3rd most important river system on the planet, and one of the most biologically and hydrologically diverse areas of the world (WWF 2010). The area of the basin has been estimated to be about 991,587 km^2; including landscapes of the Andes, plains of the Llanos and the Guiana shield. Nearly 65% of the Orinoco Basin is located in Venezuela and the remaining 35% in Colombia (Romero et al. 2004). This area contains high levels of species diversity. To date there are records of 17,420 species of plants, 1,300 species of birds, nearly 1,000 species of fish, 318 species of mammals, 266 species of amphibians and 290 species of reptiles (Lasso et al. 2010, WWF 2010). This area also has great ethnic diversity as it is home to indigenous groups such as the *Achagua, Amorua, Baniba, Bare, Betoye, Chiricoa, Cuiba, Guahíbos, Hoti, Kapo, Karina, Kuripako, Makaguaje, Masiguare, Ninam, Panare, Pemon, Piapoko, Piaroa, Puinave, Saliba, Sanema, Uwa, Warao, Yanomami, Yekuana and Yeral* (WWF 2010).

A previous study, aiming to identify the gaps of the NNPSA´s on a national scale, based on an ecosystem classification published in 1998 by Etter, reported for a subarea inside of the Colombian Orinoco Basin, eight totally unprotected ecosystems (Arango et al. 2003). More recently, a set of studies identifying priority areas for conservation and the representativeness of the Protected Areas on a global scale has been published. These were based on more recent ecosystem classifications and species diversity information. Some of these studies have been done on a national scale (Corzo 2009, Forero-Medina & Joppa 2010), and some on a more regional scale (Rodríguez et al. 2009, Romero et al. 2009), but none of them has looked at the whole of the Colombian Orinoco Basin and the implications of differences in legislation applicable to the various Protected Area categories.

The aim of this paper is to examine how the different Protected Area categories at present are protecting the natural ecosystems of the Colombian Orinoco Basin, and to observe how the protection could improve with new regulations, providing information for the design of future conservation strategies in this area. This was achieved by carrying out a spatial analysis to determine the level of protection of each ecosystem present in the study area.

Methods

Study area

The Colombian Orinoco Basin covers 3,447,713 km^2 that correspond to 30.4% of Colombia's terrestrial area (Romero et al. 2004). Ecosystems present in this area serve as regulators of a highly fluctuating water cycle that provides 33.8% of Colombia's fresh water supply (Andrade-Pérez et al. 2009). Romero et al. (2004) produced the Map of the Ecosystems of the Colombian Orinoco Basin. The map was created in a 1:100,000 scale using Landsat and ETM images from the 1999-2001 period, and cartography from the Instituto Geográfico Agustín Codazzi (IGAC) at the same scale, based on the methodology proposed by Rodríguez et al. (2004). This classification identified 4 great biomes (*Orobioma Del Zonobioma Humedo Tropical, Pedobioma Del Zonobioma Humedo Tropical, Zonobioma Humedo Tropical, Zonoecotono Del Zonobioma Humedo Tropical Y Pedobioma*), 22 types of biomes and 207 ecosystems, of which 51 are classified as transformed ecosystems and the other 156 as natural (Romero et al. 2004).

Data collection

Information regarding the name, management category, date of establishment, exact location and digital geographical information of all the Protected Areas and Indigenous Reserves in the Colombian Orinoco Basin was gathered from various sources. The main source of information was the inventory of Colombia´s Natural Protected Areas published by Vásquez-V. and Serrano-G. (2009), the authors made available the digital maps and shapes of all the Natural Protected Areas managed by governmental organizations, at the national, regional and local scales, established up to December 2008.

Information from Private Protected Areas was provided by the Colombian Orinoco Basin information node, of the Asociación Red Colombiana de Reservas Naturales de la Sociedad Civil – Resnatur - (Nodo Orinoquia 2010); Miguel Andrés Suarez; and the National Natural Parks Office. The Instituto Geográfico Agustín Codazzi - IGAC, provided information from Indigenous Reserves, established up to December 2008.

The user license of the digital version of ecosystem classification map was provided by Instituto de Investigación de Recursos Biológicos Alexander von Humboldt – IAvH.

Data analysis

A digital map of all the Protected Areas and Indigenous Reserves established in the Colombian Orinoco Basin, up to December 2008, was created using ArcGIS 9.3.

A major difficulty in the construction of the map was that some areas overlapped. The majority of the overlaps were cases in which a small Protected Area was embedded inside a bigger Protected Area; for those cases we completely eliminated the small

Protected Area from the map, taking into account that the bigger area for all cases had a better protection scheme than the smaller one. In cases where the limits of the areas overlapped, we used a hierarchical system, erasing parts of the local government Protected Areas first, the regional governmental Protected Areas secondly and finally from the Indigenous Reserves giving priority to the National Parks over all the Protected Areas.

The map of Protected Areas and Indigenous Reserves of the Colombian Orinoco Basin was superimposed over the ecosystem classification map, using the intersect function of the analysis tools in ArcGIS 9.3. The resulting shape file in the Magna Colombia Bogotá coordinate system was projected to calculate the areas in km^2 using ArcView GIS 3.2. The resulting attribute tables were exported to Microsoft Excel and area totals were calculated using pivot tables. The ecosystems were organized by order of protection, from no protection at all to total protection, in terms of proportion of the total area included in Protected Areas and Indigenous Reserves, and classified into 4 levels of protection: without protection, less than 10% of total area protected, 10-50% of total area protected, and more than 50% of total area protected, based on the criterion of the CBD that the minimum of protection for an ecosystem should be 10% of its area.

Three different analyses were carried out: an analysis of ecosystem coverage of the Protected Areas included in the National Natural Parks System, considered by us to be the only truly Protected Areas in Colombia; an analysis of ecosystem coverage of all the areas of the National System of Protected Areas (SINAP) which includes National Parks, Protected Areas of the Regional Governments and Private Protected Areas; and an analysis of ecosystem coverage of all the Protected Areas plus the Indigenous Reserves to explore the benefits of declaring Indigenous Reserves as Protected Areas.

Results

A total of 132 Protected Areas and 123 Indigenous Reserves have been established in the Colombian Orinoco Basin during the period of 1945 – 2008. Due to overlapping problems, we had to completely eliminate from the analysis some PA´s and Indigenous Reserves resulting with a final map of 106 Protected Areas and 115 Indigenous Reserves. All the Protected Areas included in the final map sum to 52,819.69 km^2; half of this area belongs to the National Natural Parks System Areas. About 80% of the total area of the Colombian Orinoco Basin (ca. 280,000 km^2) is covered by natural ecosystems.

Analysis of ecosystem protection by existing fully Protected Areas

According to the definition of Protected Area given by the IUCN (Dudley 2008), the National Natural Parks System Areas (NNPSA) are the only Protected Areas in Colombia that should be considered as truly protected. Thus, an analysis of ecosystem coverage with only this Protected Area subcategory was carried out.

Table 1. Protection levels of natural ecosystems in National Natural Parks System Areas of the Colombian Orinoco Basin.

Level of protection	Number of natural ecosystems	Proportion of total natural ecosystems
Without protection	67	43%
Less than 10% of total area protected	32	21%
10–50% of total area protected	35	22%
More than 50% of total area protected	22	14%
Total	156	100%

The National Natural Parks System in the Colombian Orinoco basin has 2 National Nature Reserves (Puinawai and Nukak), 2 National Natural Parks (El Tuparro and Sierra de La Macarena), and small fragments of other 7 National Natural Parks. All of these areas add up to 28,508.78 km^2, of which ca. 27,000 km^2 are covered with natural ecosystems (94%). The NNPSA´s protect almost 10% of the 280,000 km^2 of natural ecosystems found in the Colombian Orinoco Basin.

The ecosystem coverage analysis shows that with the NNPSA´s 43% of natural ecosystems are not protected at all and 21% are inadequately protected (Table 1). On the other hand, 1% (2) of ecosystems is completely protected inside the NNPSA´s.

Analysis of potential ecosystem protection

Taking in to account that by July 2011, all previously established Protected Areas should be included in the National System of Protected Areas (SINAP), we carried out an analysis to determine ecosystem protection by all the Protected Area categories in the Colombian Orinoco Basin. It is important to highlight that legalization of the previously established Protected Areas, by including them in the SINAP, is not enough to ensure their protection. We believe ecosystem protection will not be satisfactorily achieved, unless all the categories in the SINAP are legally protected in the same way that the NNPSA are, preventing the possible loss of these areas to mining and drilling projects and other unfortunate circumstances. This is why we refer to this analysis as potential ecosystem protection.

The 106 Protected Areas included in this analysis sum to 52,819.69 km^2, with ca. 42,000 km^2 covered with natural ecosystems (79%), which equates to 15% of the 280,000 km^2 of natural ecosystems found in the Colombian Orinoco Basin. This analysis shows that Protected Areas in the Colombian Orinoco Basin leave 24% of natural ecosystems totally unprotected and 27% inadequately protected (Table 2). However, 8% (13) of natural ecosystems would be completely protected by all the PA´s of the SINAP.

Table 2. Protection levels of natural ecosystems in Protected Areas of the SINAP in the Colombian Orinoco Basin.

Level of protection	Number of natural ecosystems	Proportion of total natural ecosystems
Without protection	38	24%
Less than 10% of total area protected	42	27%
10–50% of total area protected	36	23%
More than 50% of total area protected	40	26%
Total	156	100%

The Indigenous Reserve as a Protected area category

The 115 Indigenous Reserves (IR) of the Colombian Orinoco Basin used in this study sum to 87,729.95 km^2, covering 25% of the study area. We estimate that nearly 97% of the area of Indigenous Reserves is covered with natural ecosystems. Incorporating the IR's as a fully Protected Area category in the SINAP would increase the area protected in the Colombian Orinoco Basin up to 140,549.64 km^2 (50% of the Colombian Orinoco Basin) of which approx. 125,000 km^2 are covered with natural ecosystems. This would represent protection for 45% of the 280,000 km^2 covered with natural ecosystems in the Colombian Orinoco Basin. Integrating IR´s into the SINAP as a fully Protected Area category leaves only 6% of natural ecosystems totally unprotected (Tables 3 and 4). On the other hand, 12% (20) of natural ecosystems would be completely protected under this scenario.

Discussion

Data collection for this analysis was very difficult because the information on Protected Areas is scattered around many institutions. Although the objective was to observe the establishment of Protected Areas up to the present time, this was not possible due to limitations of the information provided by some of the sources, which had information only up to December 2008.

In regards to the proportion of land identified as covered with natural ecosystems in the Colombian Orinoco Basin, a study on deforestation (Sanchez-Cuervo et al. 2012) estimated that some areas in the Llanos ecoregion have lost up to 27% of their woody vegetation cover in the last decade. Another study on land cover change of the natural savannas by Etter et al. (2010), has shown that, for the 2000-2007 period, the natural savannas have been destroyed at an annual rate of more than 1,000 km^2 and converted to pastures and oil palm plantations. This affects the results reported here as the images used for the ecosystem classification are dated in 1999-2001, and it is uncertain how land cover has changed for other natural ecosystems. For future studies we recommend to evaluate change in land cover and conversion of natural ecosystems inside the Protected Areas.

Table 3. Protection levels of natural ecosystems in Protected Areas and Indigenous Reserves of the Colombian Orinoco Basin.

Level of protection	Number of natural ecosystems	Proportion of total natural ecosystems
Without protection	10	6%
Less than 10% of total area protected	21	13%
10–50% of total area protected	45	29%
More than 50% of total area protected	80	51%
Total	156	100%

Table 4. Names and total area of ecosystems of the Orinoco River Basin that appear to be unprotected. Descriptions and distribution of these ecosystems can be found in Romero et al. 2004.

Natural Ecosystem	Area (Has)
Anfibioma de Arauca - Casanare_Sabana en piedemonte antiguo y tectonizado	10,408.8
Anfibioma de Arauca - Casanare_Sabana inundable en terraza alta aluvial de rio andinense	94,584.0
Helobioma de la Orinoquia y Amazonia_Sabana de desborde en llanura aluvial con influencia eolica	20,550.1
Orobioma de paramo de la cordillera Oriental_paramo humedo en montaña estructural erosional	19,807.5
Orobioma de paramo de la cordillera Oriental_Subparamo muy humedo en montaña estructural erosional	999.8
Orobioma subandino cordillera Oriental_BMD seco en montaña estructural erosional	5,704.5
ZHT del piedemonte Meta_BMD muy humedo a húmedo en piedemonte aluvio diluvial	38,361.9
ZHT del piedemonte Meta_BMD muy humedo a húmedo en terraza alta aluvial de rio andinense	5,784.9
Zonoecotono del zonobioma humedo tropical y pedobioma_BMD en piedemonte antiguo y tectonizado	16,814.1
Orobioma subandino cordillera Oriental_BMD humedo en montaña estructural erosional	1,757.2

Ecosystem protection by existing fully Protected Areas

Our findings show a similar pattern to the results of previous studies regarding the proportion of inadequately protected ecosystems. In 2003 Arango et al. found that for a smaller area inside the Colombian Orinoco Basin, 57% of natural ecosystems were not protected at all and 21% did not have enough area protected by the NNPSA´s. They based their study on an earlier published national classification of ecosystems. Taking into account that the area studied by Arango et al. (2003) is smaller and the ecosystem classification they used broader, it is reasonable to state that ecosystem protection by NNPSA´s has not improved in the last 7 years, mainly because no new areas have been established.

A recent study of fire regimes by Romero-Ruiz et al. (2009) reported that NNPSA´s burn very often due to the presence of Indigenous people inside the NNPSA´s. Also, it has been reported that some of these areas have management problems such as the lack of control on the population growth inside the parks and the unsustainable use of the resources (Vásquez-V. and Serrano-G. 2009), these matters should be looked at in more detail as an evaluation on the effectiveness of management plans inside the NNPSA´s.

Potential ecosystem protection

We estimate that all PA´s of the SINAP in the Colombian Orinoco Basin protect an area of 52,819.69 km^2. This number could be higher as this analysis only included areas registered up to December 2008. But it could also decrease in the future as some PA´s could be left out of the SINAP on the standardization process, depending on the criteria used to include them and the budget limitations for their management. So it is important to carry out a new census in the future, to re-evaluate ecosystem protection after the new legislation is implemented, and the SINAP organized. We recommend repeating this kind of study regularly to provide a periodical evaluation of the SINAP at regional and national scales. An important finding of this analysis, compared to the analysis of fully protected areas, is that although the protected area is almost doubled, ecosystem protection does not increase proportionally, this is a good indicative of the lack of planning and management capacities of the regional and local governments that established most of these areas.

The work that the Private Protected Areas are doing on complementing the governmental Protected Areas must be highlighted; although these areas are small, one natural ecosystem: *Helobioma de la Orinoquia y Amazonia_Sabana de desborde en llanura aluvial de rio andinense*, is being adequately protected only by private landowners, and other ecosystems have reached an acceptable level of protection (more than 10% of the area) mainly because of the Private Protected Areas.

Recent studies on fire regimes in the Orinoco Basin savannas have found that private ranches dedicated to cattle farming on native vegetation, tend to burn less often than other areas in this region (Romero-Ruiz et al. 2009). This might be a good indicative of the high-quality management capacity of private landowners.

The national and regional governments could rely on the civil society to help them achieve the nation's conservation goals but this is only possible if the Private Protected Areas become fully protected, and new incentives and mechanisms are given to private landowners to establish and maintain Private Protected Areas.

There is some agreement between the distribution of unprotected and inadequately protected ecosystems reported here with published maps from other studies of identification of priority areas for conservation, (Rodríguez et al. 2009, Romero et al. 2009, Corzo 2009), although none of the previous studies looked at the whole of the Colombian Orinoco Basin.

The Indigenous Reserve as a Protected Area category

Our results show that most of the lands owned and managed by indigenous people are still in very good ecological condition, based on the percentage of natural ecosystems they hold, specially compared to the Protected Areas of the SINAP. Making the Indigenous Reserves a Protected Area category would help greatly on the conservation of the Colombian Orinoco Basin, but this is a significant national debate, with a lot of controversy around it.

At the moment, if any indigenous group wants to protect biodiversity in its territories in the long term, it should follow the extraordinary example Ayawa people in the Amazon region, who got the Ministry of Environment to declare their Indigenous Reserve a National Natural Park, the Yaigoje Apaporis, committing to promote their traditional ways of life and implement management plans (Macuna 2009).

Another example of the willingness of Indigenous people to aid in the conservation of biodiversity in their territories is the Selva Matavén Indigenous Reserve; this reserve was created after 16 Indigenous Reserves in its surroundings, from different ethnic groups, got together to protect this forest that is sacred to all of them (Mora et al. 2002). Now the ca. 20,000 km^2 of Selva Matavén need the double protection scheme, with the help of the National Natural Parks System, just like the Yaigoje Apaporis, or another legally viable solution.

Previously published literature on fire regimes in this area has shown that burning occurs more often in the natural savannas inside Indigenous Reserves than in private ranches. This should be looked at in more detail as it could help understand the effect of traditional practices on natural ecosystems (Romero-Ruiz et al. 2009).

General considerations

Special attention should be paid to the 10 ecosystems that appear to be unprotected in the three levels of analysis (Table 4). Urgent action may be needed to protect those ecosystems from disappearing, as they are not present in any of the PA´s or Indigenous Reserves of the Colombian Orinoco Basin. Land tenure is a truly problematic situation in Colombia, and awareness of unprotected ecosystems should be raised to the Ministry of Agriculture when allocating State property land to the people. These ecosystems should be excluded from any land reform, or the property titles of these areas should be given to NGO´s and private landowners committed to biodiversity conservation.

Etter et al. (2010) made projections on the change in land cover of the Colombian Orinoco Basin, showing that it is possible to lose more than 22,350 km^2 of natural savannas in the next 10 years, their finding should be taken into account in future efforts to protect the ecosystems that are currently unprotected to avoid losing them forever.

Conclusions

There are 132 Protected Areas and 123 Indigenous Reserves in the Colombian Orinoco Basin. This area has 52,819.69 km^2 of Protected Areas with 79% of their area covered with natural ecosystems; and 87,729.95 km^2 of Indigenous Reserves with 97% of their area covered with natural ecosystems. An estimated 36% of ecosystems are adequately protected by fully protected areas; these areas leave 43% of natural ecosystems totally unprotected, and 21% inadequately protected, defined as less than 10% of total area inside a Protected Area. Ecosystem protection would improve if all categories in the SINAP

would be legally protected from sudden disappearance or losing areas for mining and drilling. A much better protection of ecosystems would be achieved if the Indigenous Reserves were a Protected Area category or if Indigenous Reserves could have a mechanism to declare some of their territories fully Protected Areas. Ultimately, 10 natural ecosystems were found to be completely unprotected in the three levels of analysis of this study.

Recommendations

Legislation should be modified so that all Protected Area categories in Colombia are fully protected, to ensure real *in situ*, long-term conservation of biodiversity and natural ecosystems.

Incentives should be used to promote the creation and maintenance of Private Protected Areas

Legal mechanisms should be implemented so that Indigenous Reserves can officially aid in the *in situ* conservation of natural ecosystems in Colombia more easily.

Urgent actions should be taken to ensure protection of the natural ecosystems that fall outside Protected Areas and Indigenous Reserves in the Colombian Orinoco Basin, as these may be significantly endangered.

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